AGU PUBLICATIONS

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Supporting Information for

Image-Based Modeling of Granular Porous Media

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Contents of this file

Introduction

In this Supporting Information, two important results are discussed. First, the results of the SNESIM algorithm, as one of the best methods, are discussed. Then, in the next section, the results of our proposed algorithm and the SNESIM method are compared, in terms of flow behavior, to the original data. The steps and boundary conditions for conducting the flow simulation are also reviewed.

S1. Previous Results.

As mentioned in the main text of the paper, we used the single normal equation simulation (SNESIM) algorithm to generate realizations of the 3D image shown in Figure 2(a) of the main text. The SNESIM algorithm is considered a highly efficient method for reconstructing geo-media. Here, we present the results obtained by the SNESIM method. One realization of the image generated by the algorithm is presented in Figure S1, which should be compared with those shown in Figures 2(a) and 2(b). As can be seen, the shape of particles is not reproduced.

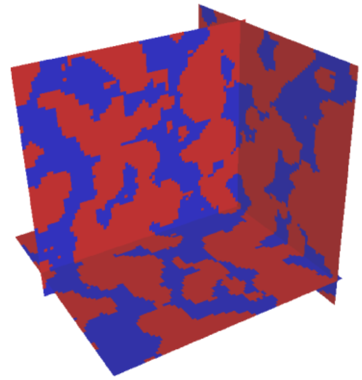


Figure S1. One realization of the image shown in Figure 2(a) of the main text generated using the SNESIM algorithm.

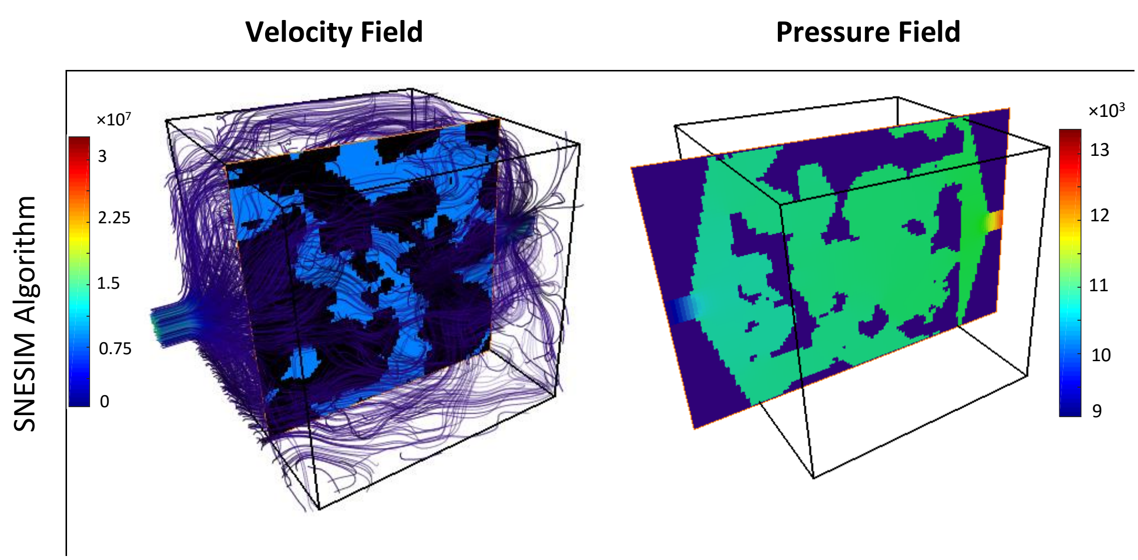
S2. Flow Simulation Descriptions and Results

The model was also used in the flow simulation, in order to compute the absolute (single-phase) permeability, K. To do so, we solved numerically the Stokes' equation, together with the mass continuity equation:

$$\vec{\nabla}.\vec{\mathrm{V}} = 0 \quad \text{(S1)}$$

$$\mu\nabla^2\vec{\mathrm{V}} - P = 0 \quad \text{(S2)}$$

assuming that the fluid is incompressible and Newtonian, and the flow is at steady state and in the laminar regime (i.e. low Reynolds number). Here, P is the fluid pressure, V is its velocity, and μ is its dynamic viscosity. The numerical simulation used the finite-volume method by which the governing equations are discretized on a staggered grid, and the pressures and velocities are computed, respectively, at the center and faces of the voxels [Harlow and Welsh, 1965]. The boundary conditions were an imposed pressure difference across the model in one direction and impermeable boundaries in the other two directions. The inlet and outlet pressures were, respectively, 130,000 Pa and 100,000 Pa. The fluid viscosity of was taken to be 0.001 Pa.s. The velocity and pressure fields for the samples are shown in Figure S2.



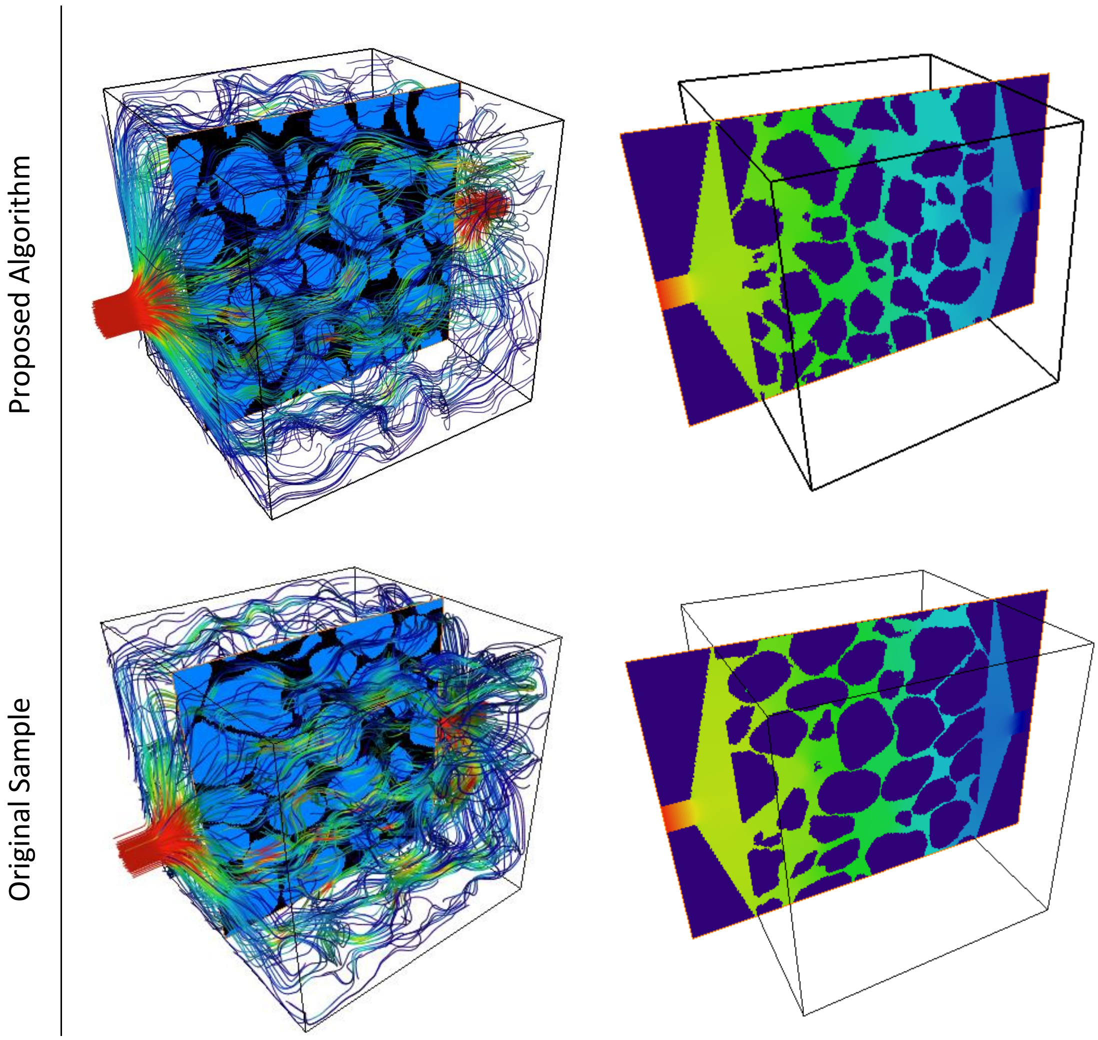


Figure S2: The velocity and pressure fields in the original sample (image), a realization generated by the proposed algorithm, and one generated by the SNESIM method.

A more quantitative comparison between the two methods is made by calculating the average fluid pressure distribution in the flow direction, with the average taken over the cross section of the sample perpendicular to the direction of the flow. The results are shown in Figure S3.

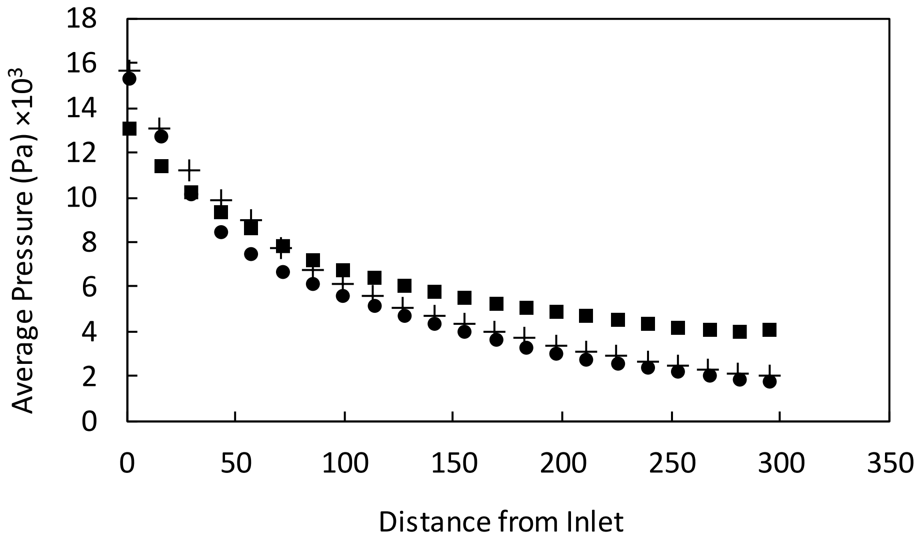


Figure S3: Comparison of the average fluid pressure in the direction of flow, computed in the original image (solid circles), and in the realizations generated by the proposed algorithm (crosses) and by the SNESIM (squares)